



Sirui Lu


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Research Interests


The main theme of my research is to bring machine learning and (quantum) physics together. I use modern machine learning and artificial intelligence techniques to accelerate progress in quantum simulation and algorithms; meanwhile I also use physics principles to understand and design better AI methods.

- **Quantum Algorithms & Simulation:** Finite-temperature simulation of quantum many-body systems, hybrid quantum-classical methods, quantum cooling and filtering protocols
- **AI for Quantum:** Neural network quantum states, variational thermal state approximations; automated scientific discovery with language agents
- **Physics for AI:** Tensor-network-based machine learning; thermodynamics of machine learning


Education

 **Dr. rer. nat in Physics** Oct. 2021 – present
Max-Planck Institute of Quantum Optics, Technical University of Munich Garching, Germany

 Supervisor: Prof. Dr. [Ignacio Cirac](#)
(Director, Theory Division, MPI of Quantum Optics)

 **Master of Science in Quantum Science and Technology (1.0/1.0, with distinction)** Oct. 2020 – Sep. 2021

Technical University of Munich and Ludwig Maximilian University of Munich Munich, Germany
Thesis: *Tensor networks and efficient description of classical data*
Supervised by Prof. [Ignacio Cirac](#)

 **Bachelor of Science in Math and Physics (3.6/4.0)** Aug. 2015 – July 2019
Department of Physics, Tsinghua University Beijing, China

Chi-Sun Yeh Prize (Top 4 out of 100 physics undergraduates at Tsinghua) 2019
Thesis: *Applications and implementation of quantum random unitaries*
Supervised by Prof. [Luming Duan](#)

 **Visiting Student (5.0/5.0)** Sep. 2017 – May 2018
Department of Physics, Massachusetts Institute of Technology Boston, USA

Works

▷ 19 publications

▷ Citations: 1313

▷ h-index: 14

Book

- [b1] **Generative AI and Stochastic Thermodynamics: A Tale of Free Energies**
Max Welling, Sirui Lu, Lars Holdijk
To be published by Cambridge University Press (July 2026)

Publications & Preprints

- [14] **Co-designing quantum codes with transversal diagonal gates via multi-agent systems**
Xi He, Sirui Lu, Bei Zeng
arXiv:2510.20728 (2025)
- [13] **Quantum algorithms for cooling: A simple case study**
Daniel Molpeceres, Sirui Lu, J. Ignacio Cirac, Barbara Kraus
Phys. Rev. Research **7**, 033162 (2025)
- [12] **Variational neural and tensor network approximations of thermal states**
Sirui Lu, Giacomo Giudice, J. Ignacio Cirac
Phys. Rev. B **111**, 075102 (2025)
- [11] **Tensor networks and efficient descriptions of classical data**
Sirui Lu, Márton Kanász-Nagy, Ivan Kukuljan, J. Ignacio Cirac
Phys. Rev. A **111**, 032409 (*Editors' Suggestion*) (2025)
- [10] **Algorithms for quantum simulation at finite energies**
Sirui Lu, Mari Carmen Bañuls, J. Ignacio Cirac
PRX Quantum **2**, 020321 (2021)
- [9] **Quantum federated learning through blind computing**
W. Li, Sirui Lu, Dong-Ling Deng
Science China Physics, Mechanics & Astronomy, **64**, 100312 (2021)
- [8] **Quantum adversarial machine learning**
Sirui Lu, L.-M. Duan, D.-L. Deng
Phys. Rev. Research **2**, 033212 (2020)
- [7] **Determining system Hamiltonian from eigenstate measurements without correlation functions**
S.-Y. Hou, N. Cao, Sirui Lu, Y. Shen, Y.-T. Poon, B. Zeng
New Journal of Physics **22**, 083088 (2020)
- [6] **Efficient representation of topologically ordered states with restricted Boltzmann machines**
Sirui Lu, Xun Gao, L.-M. Duan
Phys. Rev. B **99**, 155136 (2019)
- [5] **Machine learning topological phases with a solid-state quantum simulator**
W.-Q. Lian*, S.-T. Wang*, Sirui Lu, Y.-Y. Huang, F. Wang, X.-X. Yuan, W.-G. Zhang, X.-L.

Ouyang, X. Wang, X.-Z. Huang, L. He, X.-Y. Chang, D.-L. Deng, L.-M. Duan
Phys. Rev. Lett. **122**, 210503 (2019)

- [4] **Local-measurement-based quantum state tomography via neural networks**
T. Xin*, Sirui Lu*, N. Cao*, G. Anikeeva, D. Lu, J. Li, G. Long, B. Zeng
npj Quantum Inf. **5**, 109 (2019)
- [3] **Optimizing QAOA: success probability and runtime dependence on circuit depth**
Murphy Yuezhen Niu, Sirui Lu, Issac L. Chuang
arXiv: 1905.12134 [quant-ph] (2019)
- [2] **Separability-entanglement classifier via machine learning**
Sirui Lu*, S. Huang*, K. Li, J. Li, J. Chen, D. Lu, Z. Ji, Y. Shen, D. Zhou, B. Zeng
Phys. Rev. A **98**, 012315 (2018)
- [1] **NMRCloudQ: A quantum cloud experience on a nuclear magnetic resonance computer**
T. Xin, S. Huang, Sirui Lu, K. Li, Z. Luo, Z. Yin, J. Li, D. Lu, G. Long, B. Zeng
Science Bulletin **63**, 17 (2017)

Conference

- [c2] **Can Theoretical Physics Research Benefit from Language Agents?**
Sirui Lu, Zhijing Jin, Terry Jingchen Zhang, Pavel Kos, J. Ignacio Cirac, Bernhard Schölkopf
ICML 2026; Oral at NeurIPS 2025 AI4Science Workshop (2026)
- [c1] **Codes for simultaneous transmission of quantum and classical information**
Markus Grassl, Sirui Lu, Bei Zeng (alphabetical)
IEEE International Symposium on Information Theory (2017)

Academic Service

Peer Review

- **Journals:** Phys. Rev. X, Phys. Rev. Lett., PRX Quantum, Phys. Rev. Research, Phys. Rev. A/B/Applied, Nature Commun., Commun. Phys., Quantum, Quantum Inf. Proc.
- **Conferences:** QIP, QCTiP, IEEE ISIT, IEEE J-SAI

Honors and Awards

- Chi-Sun Yeh Prize (Top 4 of 100 physics undergraduates, Tsinghua University) 2019
- Tsinghua Xuetaang Talents Program 2015–2019
- Qualcomm Scholarship 2018

Technical Skills

- **Programming:** Python, Julia, MATLAB, TypeScript, JavaScript, HTML/CSS, Mathematica
- **ML/AI Frameworks:** PyTorch, TensorFlow, JAX, scikit-learn
- **Development:** Git, Linux/Unix, Docker, Jupyter, LaTeX